### ****Simple electric circuits****

Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

### Apparatus and materials: Electronics Snap-kit

### http://hyperphysics.phy-astr.gsu.edu/hbase/class/phscilab/imglab/Plexpersp.gifQuantitative investigation of voltage, current, and Ohm's law.

#### ****Objectives:****

* draw circuits conventionally using standard symbols and straight lines for the connecting wires
* learn how to construct circuits from circuit diagrams
* discuss the meaning and results of a circuit diagram
* using their own ideas for circuits- predict how each circuit will behave, giving a reason, before trying it out
* gain confidence in setting up their own circuits.

**Background**

* Electric current is the flow rate of electric charge and is measured in amperes.
* The current transports electrical energy along conductors.
* Voltage (V) is a measure of energy per unit charge between two points in the circuit. One may think of voltage as the effective "pressure difference" which causes the current to flow.
* Resistance (R) is the opposition to current flow and is measured in ohms. In practice, resistors take the form of light bulbs, toasters, heaters and other devices which use electrical energy to perform useful tasks as well as the undesirable form of resistance in electrical wiring that transports the electrical energy to you.

**Ohm's Law** will determine the voltage, current, or resistance in a circuit. **Ohm's law simply states that the current in a circuit is directly proportional to the voltage and inversely proportional to the resistance in the circuit:**

**Safety:** Modern dry cell construction uses a steel can connected to the positive (raised) contact. The negative connection is the centre of the base with an annular ring of insulator between it and the can. Some cell holders have clips which can bridge the insulator causing a 'short circuit'. This discharges the cell rapidly and can make it explode. The risk is reduced by using 'low power', zinc chloride cells not 'high power', alkaline manganese ones.

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| **http://hyperphysics.phy-astr.gsu.edu/hbase/class/phscilab/imglab/ecomponent.gifThe following symbols will be used in the circuit diagrams.** |

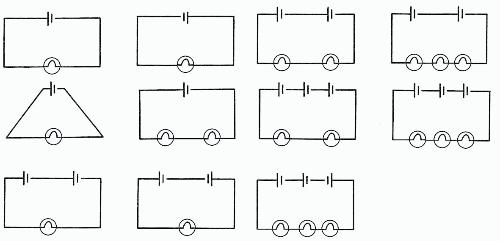
An electric circuit consists of a completer closed path (or paths) for electric current. A "series" circuit has only one path for the electricity to follow. A "parallel" circuit has two or more paths for the electricity.

**Symbols and instrumentation:**

* A wire offers essentially zero resistance in most practical circumstances.
* The "battery" will be a connection on the laboratory tables to a central DC electric supply.
* The same laboratory meter will be used for both the ammeter and voltmeter functions. You will need to select the correct function with the selector switch.

An **ammeter** will always be wired in series in a circuit. Failure to do this will result in blown fuses or damaged meters. Recall that the current has only one path to flow in a series connection, so the ammeter measures the current that flows through the circuit elements which are in series with it. The ammeters to be used will measure in milliamperes or 10-3 amperes.

A **voltmeter** is always wired in parallel with the circuit elements it is testing and measures the voltage change across them.

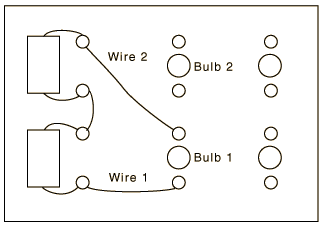
**Notice that the diagrams below indicate switched poles of the battery.**

**Make sure that you read the instructions which are bulleted to ensure that you have answered everything required.**

**Procedure:**

* **Note down what you observe for each step. Answer the questions using the information gained from these experiments as well as others as indicated.**
* **Indicate on the diagrams if the bulbs are brighter, stay the same brighntess, dim, etc. Predict the causes for these results for each.** Use words/phrases as answers unless you are summarizing your work (brighter, same, dimmer, more energy, less energy).
* *If you are developing your own circuits for the questions below, use the appropriate symbols and draw your circuit neatly.*

1. Copy the first circuit diagram. Set up the circuit using the equipment provided. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Repeat this procedure for each of the circuits shown, describing what occurs with each (brightness/dim, etc.) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. Connect a battery cell to a lamp to make it light. Try the cell connections the other way round. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. Try the circuit with a different shape. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
5. Try the cell with two lamps. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
6. Repeat everything done already with one lamp but using an extra cell. Try the cells facing the same way, and facing opposite ways \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
7. Repeat everything with two lamps and two cells. The two cells connected in opposite senses so that their voltages (if equal) will cancel out. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
8. Try again with two lamps and three cells.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
9. Try again with three lamps and two cells.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
10. Try again with three lamps and 3-4 cells. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
11. Connect your circuit board as indicated in the figure and note that the bulb will light when you touch the probes together. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

12. Touch the ends of another wire with the probes. Note that the bulb lights brightly. This is an indication of good electrical conductivity since the current through the bulb is directly related to brightness. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

13. Test several other items and record your results. Include a coin, your skin, and a beaker of distilled water and tap water. Be sure that the probes are in contact with the material being measured but not with each other. List the materials tested and your conclusions about their conductivity.

Materials & Conductivity \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

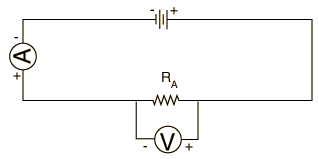
\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Rewire the circuit as shown in the diagram below. Is this a series or parallel circuit?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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| 1. http://hyperphysics.phy-astr.gsu.edu/hbase/class/phscilab/imglab/bulbser.gifNow remove wire #2 and connect it to bulb #2. Connect another wire from bulb #2 to bulb #1. *The figure illustrates the circuit.* 2. How does the brightness of each bulb compare with that of the bulb in procedure step 4. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 3. Why is it different? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 4. Unscrew one bulb. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 5. What happens and why? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |  |
| 1. Wire the circuit shown. **Show on the diagram or on a sketch the path(s) of current flow.** Is this a series or parallel circuit? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Unscrew one bulb. Describe what happens and why. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_   http://hyperphysics.phy-astr.gsu.edu/hbase/class/phscilab/imglab/bulbpar.gif   |  |  | | --- | --- | | 15. Develop a different circuit of your choice using 2 resistors from your kit. The circuit should have at least 5 parts and function. **Draw the schematics (circuit diagrams).** |  |  |  |  | | --- | --- | | 1. Develop a different circuit of your choice using at least **4 different resistors**  from your kit. The circuit should have at least 5 parts and function. | **Draw the schematics (circuit diagrams).** | |  |

**Summarize your findings**

1. Does the shape of the circuit matter?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Does the shape matter if there is more than one cell\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. What happens when bulbs in series have additional bulbs added? (same brightness/dimmer/brighter)\_\_\_\_\_\_\_\_ \_\_\_\_\_\_
4. One cell with two lamps connected in parallel shows that the lamps have\_\_\_\_\_\_\_\_\_ (same brightness/dimmer/brighter)
5. Which uses the most energy? Two lamps in series with a cell or two similar lamps in parallel with a cell?) \_\_\_\_\_\_\_\_\_\_\_\_\_

**Lab with a multimeter**

**Make observations at each stage!**

1. Wire up the circuit as shown with the ammeter in place, observing the correct polarities. Set your meter selector switch for DC amperes and the range to the maximum. The "battery" in this case will be the round Flex Lab receptacles on your lab table which are connected to a DC power supply - **DO NOT APPLY POWER** until the circuit has been approved by the instructor.

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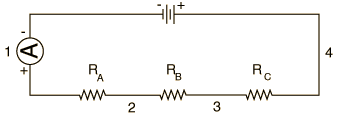
1. After approval, apply power by connecting the wires to the DC receptacles and record the ammeter reading in milliamperes. Repeat the current measurement each of the other resistors by placing them in the circuit in place of the first one.

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1. Disconnect the power leads and remove the ammeter from the circuit. Switch it to DC volts and connect it in parallel across the resistor. Reconnect the DC voltage and measure the voltage across the resistor. Repeat for the other resistors.

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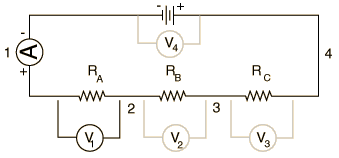
1. You now have voltage and current measurements for each resistor. Use Ohm's law to calculate the resistance for each resistor and compare the calculated value obtained from the labeling on the resistor or from the color code on the resistor.

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**Distribution of Current.**

1. Form the series circuit shown. Since you will again be using the meter as an ammeter, reset its selector switch to DC amperes. Make sure it is correct before applying power.
2. Wire the ammeter successively in locations 1,2 3 and 4 and record the current value in each location. Note that conventional current is taken to be clockwise in this circuit, while the electrons will be circulating counterclockwise.
3. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 3. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 4. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. What can you conclude about the current in a series circuit from your measurements?

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**Distribution of Voltage**

1. The circuit wired in Part B will now be used to measure voltages. The connections illustrated below will be used, but since you will be using the same meter for an ammeter and a voltmeter, the ammeter will not be in place when you are measuring the voltages.
2. Measure the voltage across each resistor in turn and across the entire circuit, as indicated by V4. Record the results. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. Compare the sum of voltages across the individual resistors to the voltage across the entire circuit. What can you conclude about the voltage in a series circuit? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**QUESTIONS:**

1. What functions does a wire serve? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Are there insulators associated with your apparatus? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ What do they do? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. What, if anything, flows through the wires? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. Why must there be two connections to a battery and to a light bulb?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. If you have a 120 volt appliance and 2 amperes of current flow through it, what is the power used by it in watts? \_\_\_\_\_\_\_\_\_\_\_

What is its resistance in ohms?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Why are your household receptacles wired in parallel rather than in series? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_